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Procedures defines methods of evaluating the suitability of sleeping bags and related equipment for use by the U.S. Army.			

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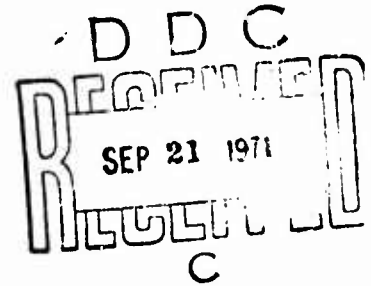
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AD 729600  
14 July 1971

Materiel Test Procedure 10-2-160  
General Equipment Test Activity

US ARMY TEST AND EVALUATION COMMAND  
COMMODITY ENGINEERING TEST PROCEDURE

SLEEPING GEAR



1. OBJECTIVE

This document provides the test methodology and testing techniques to determine the technical performance and safety characteristics of sleeping gear and associated equipment as described in Materiel Need (MN) and to determine the items suitability for service tests.

2. BACKGROUND

a. Light weight, compact sleeping gear that is adequate for the temperatures to be encountered is probably the most important item provided for the comfort of the soldier next to food and clothing. In order to be at peak efficiency, the individual must be well fed, comfortably clothed, and rested. It is necessary, therefore, that research, development and testing of new designs and materials be continued to provide at all times the best possible items in this category.

b. Since the soldier is prone to lighten his load wherever possible, he may well decide to abandon his sleeping gear if it is not lightweight, compact and truly functional.

c. Sleeping gear is frequently subjected to rough usage. It is thrown into the back of a vehicle, used as a seat, pitched off onto the ground (dry or wet) and otherwise abused. These conditions of use must not be overlooked in its design.

d. Extensive studies have been made of sleeping bags, their filling materials and auxiliary equipment such as pads, mattresses, wind breaks, foot bags, etc. From these studies there have been established a number of basic criteria subsequently confirmed by laboratory tests and field trials that should be carefully considered in the evaluation of new designs of sleeping gear.

e. The basic item of sleeping gear is the sleeping bag. The most important factor in the overall efficiency of a sleeping bag is the effectiveness of its insulation. The criteria for the evaluation of the insulation properties of a sleeping bag is set forth in Appendix A.

This MTP is intended to be used as a basic guide in preparing actual test plans for the subject material. Specific criteria and test procedures must be determined only after careful appraisal of pertinent MN, and other applicable documents.

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-1-

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14 July 1971

f. The design of a sleeping bag is of importance secondary only to its insulating properties. Sufficient length for taller men is absolutely essential. A very tall man in an average size bag may experience uncomfortably cold feet. Furthermore the cramped position, caused by inadequate length, is not only uncomfortable but the pressure of the feet against the bag reduces the effective insulation of the bag around them. Even in less extreme cases of inadequate length, painful leg and body cramps may well develop after only one or two hours of use.

g. In extreme cold, the use of auxiliary equipment becomes necessary if the sleeping bag is to provide adequate comfort. Additional insulation under the body in the form of a mattress pad is an excellent solution. Additional layers of wind break material may be of significant value in extending the temperature range of some bags but not of others. The usefulness of wind break material depends upon the type of basic insulating material in the bag itself.

h. It has been determined that under most conditions with a sleeping bag, pad and wind break of adequate design, the optimum clothing to be worn in the bag should consist of one suit of wool knit underwear, one pair of heavy wool socks, one pair of arctic socks, a woollen scarf and a torque. This clothing ensures a layer of warm air next to the skin, even if the hood of the sleeping bag is open temporarily. Also, the clothing protects a man from extreme cooling when he first enters the bag and he is more comfortable while dressing in the morning.

Also, there is a possibility that the sleeping bag be designed such that the user sleeps with all or part of the clothing he has worn that day and will wear the next day. However, individuals should avoid wearing too many clothes in the sleeping bag. When too many clothes are worn they tend to bunch up, especially at the shoulders, thereby restricting circulation and inducing cold. Too many clothes also increase the bulk and place tension upon the bag, thus decreasing the size of the insulating airspaces between layers and reducing the efficiency of the insulation. In addition, too many clothes may cause the soldier to perspire and result in excessive moisture accumulating in the bag, a condition which will likewise reduce the bag insulating qualities.

The subtests described herein shall provide the means of assessing the technical performance and safety characteristics of sleeping gear and associated equipment and shall be used as a basis for determining the suitability of the item for service testing.

### 3. REQUIRED EQUIPMENT

One or more of the following items and/or facilities may be required to obtain data during the various evaluations:

- a. Steel tape, 8' long, calibrated in feet and inches.
- b. Weighing scales, beam balance type, scale divided to 100th of a pound.

14 July 1971

- c. Weighing scales, beam balance type, capacity 100 kg.
- d. Still camera, film and flash bulbs.
- e. Skin probe thermocouples and read-out device (°F.).
- f. Rectal thermometers.
- g. Equipment to measure oxygen consumption by human test subject in liters.
- h. Equipment to measure lung ventilation.
- i. Sauter balance (grams and kilograms).
- j. Identical clothing, sized for each test subject.
  - 1) 1 suit wool underwear.
  - 2) 1 pair heavy wool socks.
  - 3) 1 pair knee length wool Arctic socks.
  - 4) 1 torque or wool cap.
  - 5) 1 wool knit scarf.
  - 6) 1 pair wool mittens.
- k. Refrigerated room with temperature control from ambient down to -40°F. Source of air agitation to provide air movement in refrigerated room approximating a turbulent wind velocity of 5 MPH.
  - l. Thermal conductivity measuring apparatus.
  - m. Slab of stone, one side polished smooth, approximate size of an air mattress and sufficiently thick to weigh 165 pounds.
  - n. Test instruments and equipment as specified in durability tests, paragraph 6.2.2 below.
  - o. Waterproof clothing bag.
  - p. Vibration test equipment (MIL-STD 810B, Method 514.1 Procedure X, Time Schedule IV).

## 4.

REFERENCES

- A. Army Regulation AR 70-38, Research and Development: Research and Development, Test and Evaluation of Material for Extreme Climatic Conditions.
- B. AMCP 706-134, Engineering Design Handbook, Maintainability Guide for Design.
- C. USATECOM Regulation 70-23, Research and Development: Equipment Performance Reports (EPRs).
- D. USATECOM Regulation 385-6, Safety: Verification of Safety of Materiel During Testing.
- E. USATECOM Regulation 700-1, Quality Assurance: Value Engineering.
- F. USATECOM Regulation 750-15, Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- G. USAGETA Document, Human Factors Evaluation Data for General Equipment (HEDGE).
- H. MIL-STD-129, Marking for Shipment and Storage.
- I. MIL-STD-810B, Environmental Test Methods.
- J. MIL-STD-1472, Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

- K. Federal Specification CCC-T-191, Textile Test Methods.
- L. Federal Specification KK-L-311, Leather, Methods of Sampling and Testing.
- M. Federal Test Method Standard 151, Metals, Test Methods.
- N. MTP 10-2-500, Physical Characteristics.
- O. MTP 10-2-501, Operator Training and Familiarization.
- P. MTP 10-2-502, Durability.
- Q. MTP 10-2-503, Surface Transportability (General Supplies & Equipment).
- R. MTP 10-2-505, Human Factors Evaluation.
- S. MTP 10-2-507, Maintenance Evaluation.
- T. MTP 10-2-511, Quality Assurance.
- U. MTP 10-2-512, Reliability.
- V. TM 10-275, Cold Weather Clothing and Sleeping Equipment.
- W. TM 10-354, Army Fixed Laundry Organization.
- X. American Association of Textile Chemists and Colorists (AATCC) Manual.
- Y. American Society of Testing and Material (ASTM) Standards Manual.

5. SCOPE

5.1 SUMMARY

This procedure describes the preparation for and methods of evaluating the technical characteristics of sleeping gear and its suitability for service testing. The required tests are summarized as follows:

a. Preparation for Test - A determination of the condition and physical characteristics of the test item upon arrival. Also, to ensure that the test item is complete and functionally operational, and to provide operator training and familiarization procedures.

b. Performance - A series of subtests to determine the insulating properties of sleeping gear, moisture uptake, weight and bulk, and the characteristics of accessory equipment.

c. Environmental Tests - A series of evaluations designed to examine and measure changes in the performance and physical characteristics of the test item where it is subjected to controlled changes in its environmental parameters.

d. Durability - A series of subtests to determine the material characteristics and launderability of sleeping gear as an indication of its ability to withstand continued usage in the field.

e. Transportability - A determination of the ability of the test item to withstand the forces which it will experience during normal handling and transporting.

14 July 1971

f. Maintenance Evaluation - To determine and verify the maintenance/maintainability characteristics and requirements of the test item; an appraisal of the design and of the maintenance test package, and the calculation of indicators which express the effects of the preceding aspects.

g. Reliability - An evaluation to determine the probability that the test item will perform its intended function for a specified interval under stated conditions.

h. Safety - A determination to ascertain the safety characteristics and possible hazards of the test item.

i. Human Factors Evaluation - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria.

j. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of reducing the cost of the test item without compromising performance and safety characteristics.

k. Quality Assurance - An evaluation of the test item with the objective of appraising the quality of workmanship and the degree of material freedom from defects and flaws.

## 5.2 LIMITATIONS

a. Sleeping gear consists of blankets, sleeping bags with various insulating properties for the tropics, temperature climates or the arctic, quilted pads, air inflated pads and air mattresses. Also, sleeping bag cases and poncho liners. Although used with sleeping gear, the waterproof clothing bag and the poncho are not exclusively limited to sleeping gear, and are, therefore, excluded from specific testing.

b. Also excluded from this document are Post, Camp and Station types of sleeping gear, i.e., cots, cotton or innerspring mattresses, pillows, etc.

## 6. PROCEDURES

### 6.1 PREPARATION FOR TEST

NOTE: Prepare an Equipment Performance Report in accordance with the provisions of USATECOM Regulation 70-23 for any items that are missing, damaged or considered inadequate when completing the following procedures.



MTP 10-2-160  
14 July 1971

6.1.1 Initial Inspection

Upon receipt of the test item at the test site, perform applicable procedures of MTP 10-2-500 and inspect the test item for evidence of defects in materials and/or workmanship. Particular attention should be given to the operation of slide fasteners and other closures, if any.

6.1.2 Inventory Check

Conduct an inventory against the Basic Issue Item List (BIIL). Record evidence of the following as applicable:

- a. Missing maintenance literature or draft technical manuals.
- b. Shortages in repair parts or accessories.
- c. Missing kits.

6.1.3 Physical Characteristics

a. Determine and record the physical characteristics of the test item as described in applicable portions of MTP 10-2-500 to include the following as applicable:

- 1) Nomenclature markings.
- 2) Instructional or warning markings.
- 3) Dimensions (length and width).
- 4) New weight, dry (to nearest hundredth of a pound).
- 5) Color. (Camouflage characteristics).

b. Salt Fog Test

Subject the slide fastener to the procedures of MIL-STD-810 B Method 509, Procedure I. Use a 20% salt solution. Expose for 48 hours. Drying period shall be 48 hours. Record any evidence of corrosion.

6.1.4 Operator Training and Familiarization

Test personnel shall receive training and familiarization in accordance with applicable procedures of MTP 10-2-501 and the following:

a. Hazards. Review all hazards and safety precautions associated with using, maintaining, and testing the test item. Include the possibility of frost bite to test subject under extreme cold conditions if the test item is intended for arctic use.

b. Test subjects shall receive detailed instructions and practice in the proper use of sleeping gear to include the following:

- 1) Clothing to be worn, including importance of proper fit.
- 2) Use of accessories.

- a) Scarf to prevent frost accumulation.
- b) Importance of a pad or mattress and an additional wind break with an inadequate bag.
- c) Substitute insulation if pad or mattress is not available. (Spruce boughs; spare dry clothing).

c. Use of the poncho with a poncho liner, as a sleeping bag.  
(Cool to moderately cold temperatures.)

d. Practice in the actual use of sleeping gear.

- 1) Test subjects will be "instrumented" and clothed for the test and will sleep in their assigned gear.
- 2) Record comments of the test subjects regarding the "fit" of the sleeping system and any interference with restful sleep caused by the instrumentation. All instrumentation will be tested at this time.

e. Care and Maintenance of Sleeping Gear.

The importance of proper care and maintenance of sleeping gear will be stressed. The most important factor is cleanliness. This applies particularly to the sleeping bag. The following points should be explained and discussed in detail:

- 1) The water-repellent case always should be used over the sleeping bag.
- 2) Breathe through the face opening to prevent breath from wetting the inside of the bag. Do not put face completely inside bag. If face is cold, cover it with a muffler, coat, or towel.
- 3) Avoid perspiring while in the sleeping bag. If too warm, open the slide fastener for ventilation.
- 4) Open the bag completely and air thoroughly each day.
- 5) Use poncho under sleeping bag case for protection against ground moisture.
- 6) Dry the bag by turning it inside out and airing it whenever possible.
- 7) Fluff the bag thoroughly before each use.
- 8) Brush and clean clothing before entering bag.
- 9) Remove dirt and grease from sleeping bag by spot-cleaning with a damp cloth and soap.
- 10) When necessary the sleeping bag should be laundered in accordance with formula G, TM 10-354.

CAUTION: Because of possible health and fire hazards, sleeping bags are not dry-cleaned.

- 11) Repair all holes and tears in sleeping bag as soon as possible.
- 12) When possible, carry bag inside the waterproof clothing bag. Protect the sleeping bag when not in use by storing it in the waterproof clothing bag.
- 13) Do not overinflate a pneumatic mattress; overinflation decreases sleeping comfort. Test the inflated mattress for comfort by sitting on it. When sitting on the mattress, the buttocks should barely touch the ground.
- 14) Ordinarily the mattress is inflated by mouth only since the use of air lines or other mechanical means of inflation may tear the cemented seams. If, however, a pump is supplied and the valve is so designed, the foregoing does not apply. Air-dry a wet mattress before use whenever possible. Do not place the mattress on sharp objects that may puncture it. To detect holes in the mattress that are not apparent, immerse the inflated mattress in water and look for air bubbles. Repair small holes and tears by following instructions contained in the cold weather insulated boot and pneumatic mattress repair kit. When packing the mattress, always roll it toward the open valve to release all the air.
- 15) Use the waterproof clothing bag to protect the sleeping bag and the outer shell from moisture when stored, carried, or transported in a vehicle. Repair small holes and tears in the waterproof bag with the cold weather insulated boot and pneumatic mattress repair kit as prescribed by instructions contained in the kit.

## 6.2 TEST CONDUCT

### 6.2.1 Performance

The following subtests shall be performed on a standard item of sleeping gear, similar in design to, or one to be replaced by, the test item, as well as on the test item for comparable purposes unless data on an appropriate comparable piece of gear are already available.

#### 6.2.1.1 Insulation Properties of Sleeping Bag

a. Conduct this subtest on a raised wooden platform in a refrigerated room with a turbulent wind velocity of approximately 5 MPH. Maintain the temperature in the room at +30°F. Place the bag to be tested in place approximately 30 minutes before the test is to commence. No accessories will be used. (Pad; mattress; wind break; foot bag.)

b. Clothe the test subject in combinations of the following as appropriate:

- 1) 1 suit of wool underwear.

- 2) 1 pair heavy wool socks.
- 3) 1 pair Arctic wool socks.
- 4) Torque or wool cap.
- 5) Wool scarf (for face covering).
- 6) Wool mittens.

c. Instrument the test subject as follows:

- 1) For skin temperatures (use thermocouples):
  - a) On great toe.
  - b) On each hip.
  - c) Four places on the trunk, including the lower shoulder. (Seven locations total.)

d. Subject will enter the bag and go to sleep for one hour to approach equilibrium.

e. For the next two hours read and record:

- 1) Rectal temperature at the end of the first, second and third hours.
- 2) Skin temperatures at the seven selected points every 15 minutes.
- 3) Oxygen consumption continuously.
- 4) Lung ventilation continuously.

CAUTION: If at any time the skin temperature at any point on the body drops to 40°F. or there is any other indication of impending cold injury, the test will be suspended immediately. The test must be monitored continuously by technical personnel.

f. Administer questionnaires I, II and III, Appendix B, to test subject.

g. If more than one test item is available for this subtest, use as many test subjects as necessary to test all test items simultaneously space permitting in the environmental chamber. If the same test is repeated more than one time, test subjects should interchange test items to provide a better average.

h. Repeat the subtest specified above with cold room temperatures -10°F., -25°F., and -40°F. unless test results at higher temperatures indicate that the test item will not provide adequate protection at these lower temperatures without accessory equipment.

NOTE: Select temperatures and clothing to meet the stated design characteristics of the test item. (A bag designed for Arctic use would not be tested at +30°F.; a bag intended for the temperature zone at -25°F. or -40°F.)

6.2.1.2 Moisture Uptake by Sleeping Bag

Determine whether the test item will provide all night protection, in what manner and how much water and frost is formed in the bag, and to what extent the bag is generally comfortable.

a. Determine and record the dry weight of the test item at the start of the test. Weight should be measured to the hundredth of a pound on a sensitive scale.

b. Test subject should sleep in the bag all night (8 hours) for four successive nights in a -10°F. environment.

c. Shake bag and brush off visible frost each morning. Leave bag in cold room until next use.

d. After each use determine and record the weight of the bag:

- 1) Moisture uptake for each use as well as the cumulative uptake over four days should be determined.
- 2) If moisture accumulation has not reached a plateau after four nights use, the determination should continue until it has.
- 3) After the moisture accumulation has reached a plateau, determine and record the weight of the bag.

e. Immediately repeat insulation subtest in 6.2.1.1 above.

f. Dry the bag at room temperature. Determine and record its weight.

6.2.1.3 Weight and Bulk of Sleeping Bag

Compare the portability of the test item with standard bags.

a. Determine and record:

- 1) Weight of nearest standard bag.
- 2) Volume of nearest standard bag.
- 3) Weight of test item.
- 4) Volume of test item.

NOTE: Bags (including sleeping bag case) shall be rolled for man-carrying, all by the same technique and the same observer for the above measurements.

#### 6.2.1.4 Accessory Equipment (Covers, Pads and Mattresses)

To extend the insulating properties of a sleeping bag and provide further comfort to the user, a quilted pad of a down/feather or cellulose acetate or similar filler material may be added to the sleeping gear system. An alternative is to use an inflatable rubber pad or a pneumatic mattress. The pad should be used inside of the sleeping bag unless it is unusually bulky. The pneumatic mattress should be used outside and under the sleeping bag for comfort and to keep the bag dry.

a. Determine the thermal insulating properties as follows:

- 1) Arrange a thermal conductivity apparatus to measure the heat transfer through the pad. (Either quilted or pneumatic.) Record the results and calculate the thermal conductivity in Cals./hr./meter<sup>2</sup>/degree C.
- 2) If the apparatus available is not sufficiently sensitive to measure the relatively low conductivity of an item such as a pad, measurements must be made on human subjects.
- 3) Repeat the subtest in 6.2.1.1 above using a sleeping bag of known characteristics and a cold room temperature sufficiently low so that the bag alone is not adequate. Correlate and record the results of the two test methods, if both were used.

b. Test an inflatable pad or mattress for leakage by placing on it a slab of polished stone weighing 165 pounds and approximately the size of the bag. This will approximate the weight of a heavy man's body. The test item, to be satisfactory, should remain inflated for at least 8 hours in a temperature of -40°F.

c. Evaluate the valve mechanism of an inflatable pad or mattress.

Record:

- 1) Is a pump necessary for inflating?
- 2) Inside diameter of filling tube.
- 3) Size of plug and method of securing to prevent loss.
- 4) Ease of closure when wearing gloves.

d. Inflate the air mattress so that the test subject's buttocks just clear the ground when he is sitting on the mattress. Record comments of the test subject as to comfort when lying on his side on the mattress. Determine the tendency to roll off of the mattress, (too high in the center, or on one side).

e. Determine and record the adequacy of the quilting to prevent shifting and bunching of the filling material in a quilted, filled pad.

6.2.1.5 Sleeping Bag Performance Characteristics

Determine the performance characteristics of sleeping bags for arctic, tropic, or temperate climate use by evaluation and recording:

a. Thermal insulating properties of bag in accordance with 6.2.1.4a) above by the use of thermal conductivity apparatus.

b. Weight and bulk in comparison to standard (control) item, (Paragraph 6.2.1.3 above).

6.2.1.6 Compatibility of Case and Bag

Determine the "fit" of the sleeping bag case over the sleeping bag:

a. Do eyelets (or snaps) for lacing line up properly?

b. Are furnished laces long enough to lace the case to the bag and tie easily, especially where wearing gloves?

c. Are the eyelets in the case set in stiff material of sufficient width so that the case material cannot jam the slide fastener closure of the bag?

d. Is the case sufficiently larger than the bag so that the bag may assume its full shape without restriction?

e. Is the case too large for the bag? (Waste space resulting in reduction of insulating value.)

6.2.2 Durability

Perform applicable procedures of MTP 10-2-502 to include, but not be limited to, the following:

6.2.2.1 Material Characteristics

The following test item materials shall be examined to determine their suitability for the intended use and their ability to withstand continued usage in the field.

a. Metal components (slide fasteners, snaps).

- 1) As described in ASTM Standards Manual; Hardness: E140.
- 2) As described in FED TEST METHOD STD 151; Corrosion: Method 811.1 Salt Spray Test.

b. Textile Materials.

- 1) As described in ASTM Standards Manual:
  - a) Abrasion: D1175
  - b) Tear Strength: D1424, D2261.
  - c) Break Strength: D1682.
  - d) Elongation: D1682.
  - e) Air Permeability: D737.
  - f) Stiffness: D1388.
  - g) Fiber Identification: D276.
  - h) Fiber Count: D276.
  - i) Flammability: D1230.
  - j) Color Fastness to weather of cloth-accelerated Method: E42.
  - k) Water Absorption Tests: D583.
- 2) As described in AATCC Manual.
  - a) Colorfastness to light-accelerated Method: Procedures 16F-1964T.
  - b) Crocking: Procedure 8-1961.
  - c) Static charge tests: Procedure 76-1964.
- 3) As described in Federal Specification CCC-T-191.
  - a) Resistance to accelerated aging: Method 5512.2.
  - b) Adhesion of coating: Method 5970.
  - c) Blocking: Method 5651.
  - d) Sealed seam sealant-resistant to low temperature flexing: Method 5874.
  - e) Color fastness and legibility of labels: Method 5651-1.
  - f) Weatherometer tests for accelerated weathering: Methods 5804.1, 5512.2.
  - g) Puncture: Method 5120.
- 4) Mildew resistance tests as described in Federal Specification KK-L-311: Method 5011.

6.2.2.2 Launderability

- a. Sleeping bag or quilted pad (down/feather filled).
  - 1) Launder 25 cycles in accordance with Formula G, TM 10-354.
  - 2) Repeat subtest in 6.2.1.1 above.
  - 3) Launder an additional 25 cycles and again repeat subtest in 6.2.1.1 above.



6.2.3 Environmental Tests

NOTE: The environmental tests referenced below shall be conducted in accordance with the applicable principles set forth in AR 70-38 and/or MIL-STD-810B.

- a. Paragraph 6.1.3 Physical Characteristics.
  - 1) Salt fog corrosion test. (Slide fastener)
  - 2) Other applicable environmental test performed.
- b. Paragraph 6.2.1.2 - Moisture uptake.
- c. Paragraph 6.2.2.1, as applicable.

6.2.4 Transportability

Subject the test item to applicable portions of MTP 10-2-503 to include, but not be limited to the following:

- a. Visually inspect the test item for defects and evenness of filler material distribution before testing.
- b. Prepare both the test item and the control item for man-transport (ruck sack or similar carrier).
  - 1) Determine and record weights of the two items to nearest one hundredth of a pound.
  - 2) Determine and record volume (in cubic inches) of the two items.
- c. Pack test item for transport in waterproof clothing bag.
  - 1) Conduct vibration test in accordance with MIL-STD-810, Method 514, Procedure X, Time Schedule IV.
  - 2) After testing, inspect and record condition of filler material. (Evenly distributed or bunched.)

6.2.5 Maintenance Evaluation

Evaluate the maintenance related factors of the test item as described in appropriate sections of AMC Pamphlet 706-134 and MTP 10-2-507 with emphasis on the following:

- a. Organizational (O), Direct Support (F), and General Support (H) maintenance requirements.
- b. Operator through General Support Maintenance Literature, if applicable.

- c. Repair parts.
- d. Calibration standards and facilities.
- e. Test and handling equipment.
- f. Maintenance facilities.
- g. Personnel skill requirements.
- h. Maintainability.
- i. Availability.

6.2.6 Reliability

Evaluate and appraise the reliability related factors of the test item as described in MTP 10-2-512.

6.2.7 Safety

Provide a safety recommendation in accordance with USATECOM Regulation 385-6 and observe all normal safety precautions governing the operation of the test item and test equipment. All test personnel shall note and record the following throughout the conduct of the various subtests:

a. Any dangerous or unsafe conditions that might present a safety hazard including the cause of the hazard and the steps taken to alleviate the hazard.

b. Any safety features incorporated into the test item design. Evaluate and record comments regarding adequacy of quick release feature of closure.

c. Adequacy of warning instructions and markings.

d. Suggestions to improve the existing safety precautions.

6.2.8 Human Factors Evaluation

The test item shall be evaluated to determine the degree of which test item physical design and revealed performance characteristics conform to recognized human factors engineering design criteria. In order to facilitate this evaluation, prepare checklists of design criteria applicable to Class IV D. material as defined by Human Factors Evaluation Data for General Equipment (HEDGE). Also, incorporate applicable procedures of MTP 10-2-505 and the following:

a. General considerations to be included in checklists for all tests:

MTP 10-2-160  
14 July 1971

- 1) Adequacy of furnished instructions.
  - 2) Ease of performing tasks.
  - 3) Human factors design deficiency revealed by particular test.
- b. See Appendix B for technical performance questionnaires.
- c. Considerations to be included in checklist for the maintenance evaluation:
- 1) Ease of locating malfunction and determination of cause.
  - 2) Access to defective component.
  - 3) Ease of replacement and/or repair of malfunction.
- d. Record any inadequacies of test item design affecting ease of use with particular respect to:
- 1) Slide fastener operation (sleeping bags).
  - 2) Auxiliary closure.
  - 3) Lacings.
  - 4) Neck and head area closure.
  - 5) Ease of entering sleeping bag.
  - 6) Valve operation (inflatable pad or mattress).
- e. Record any recommendations to improve man-item effectiveness.

#### 6.2.9 Value Analysis

Throughout all tests, the test item shall be examined for any unnecessary, costly, "nice-to-have" features as described in USATECOM Regulation 700-1. Perform the following:

- a. During operation of the test item, observe for features which could be eliminated without compromising performance, reliability, durability, or safety.
- b. Question test personnel regarding features of the test item which could be eliminated without decreasing the functional value of the test item or the man-item effectiveness.
- c. Record the following:
  - 1) Nonfunctional, costly, or "nice-to-have" features of the test item.
  - 2) Test personnel comments and opinions regarding features to be eliminated.

#### 6.2.10 Quality Assurance

Throughout all tests, examine the test item for compliance with the quality requirements of the applicable MN and the provisions of MTP 10-2-511.

6.3 TEST DATA

NOTE: In compiling the Test Data section, test personnel should expound upon those data procedures which are other than quantitative in nature by recording narrative descriptions which will provide full details of conditions and/or events occurring during the conduct of the test.

6.3.1 Initial Inspection

Record the data required by applicable procedures of MTP 10-2-500 to include details of any defects found in material or workmanship, particularly slide fasteners and other closures.

6.3.2 Inventory Check

Record the following data after an inventory conducted against the BIIL.

- a. Missing maintenance literature or draft technical manuals.
- b. Shortages in repair parts, accessories, or tools (authorized tools).
- c. Missing kits.

6.3.3 Physical Characteristics

Record the following:

- a. Data required by applicable procedures of MTP 10-2-500.
- b. Clarity of nomenclature markings.
- c. Adequacy of instructional markings.
- d. Physical dimensions.
- e. Net weight (dry).
- f. Color, including comments as to camouflage characteristics.
- g. Results of salt fog test; evidence of corrosion.

6.3.4 Operator Training and Familiarization

- a. Record the data required by MTP 10-2-501.
- b. List safety hazards and precautions reviewed.

MTP 10-2-160  
14 July 1971

c. Comments of test subjects regarding the "fit" of the sleeping system and the effects of the instrumentation on sleep.

6.3.5 Performance

6.3.5.1 Insulation Properties of Sleeping Bag.

For the control item and for the test item, record the following:

- a. Name of test subject.
- b. Nomenclature of bag being tested.
- c. Temperature of room.
- d. Wind velocity.
- e. Clothing worn (by Federal stock number if applicable).
- f. Locations of thermocouples on body.

NOTE: Number each thermocouple; be sure to correlate thermocouple numbers with body locations, especially those on great toe, upper and lower hip and lower shoulder.

- g. Rectal temperature, °F.
  - 1) After 60 minutes.
  - 2) After 120 minutes.
  - 3) After 180 minutes.
- h. Skin temperature at each of seven points, °F.
  - 1) After 60 minutes.
  - 2) After 75 minutes. (Continue every 15 minutes until ....)
  - 3) After 180 minutes (9 readings).
- i. Oxygen consumption between:
  - 1) 60-120 minutes.
  - 2) 120-180 minutes.
- j. Lung ventilation between:
  - 1) 60-120 minutes.
  - 2) 120-180 minutes.

k. Retain questionnaires I, II and III.

l. If more than one test item is available and the test is repeated more than one time, record the data in a through k above for each test subject and each sleeping bag.

m. Record data specified in a through k above for test room temperatures  $-10^{\circ}\text{F.}$ ,  $-24^{\circ}\text{F.}$  and  $-40^{\circ}\text{F.}$  if test item design allows further testing at the lower temperatures.

#### 6.3.5.2 Moisture Uptake by Sleeping Bag

Record the following:

- a. Dry weight of the test item at start of test.
- b. Amount of visible frost present each morning.
  - 1) None visible.
  - 2) Slight frost (state location).
  - 3) Medium to heavy frost (state location).
- c. Weight of test item at conclusion of test on final morning.
- d. Data required in 6.3.5.1, a through k above.
- e. Weight of test item after drying at room temperature.

#### 6.3.5.3 Weight and Bulk of Sleeping Bag.

Record the following:

- a. Weight of control item (pounds).
- b. Volume of control item (cubic inches).
- c. Weight of test item (pounds).
- d. Volume of test item (cubic inches).

#### 6.3.5.4 Accessory Equipment (Covers, Pads and Mattresses).

##### 6.3.5.4.1 Thermal Insulating Properties -

Record the following:

- a. Heat transferred through the pad or mattress ( $\text{Cals./hr./meter}^2/\text{degree C.}$ ).

MTP 10-2-160  
14 July 1971

b. Data required in 6.3.5.1, a through k above and nomenclature of pad or mattress used.

6.3.5.4.2 Inflatable Pad or Mattress Leakage -

Record the following:

a. Did the pad or mattress remain inflated for 8 hours under a 165 pound load?

- 1) Yes or No -- If no,
- 2) How much under-inflated?

6.3.5.4.3 Valve Mechanism -

Record the following:

a. Method of inflating:

- 1) By pump.
- 2) By mouth.
- 3) Other.

b. Inside diameter of filler hole (in 16ths of an inch).

c. Size of plug (if any).

d. Comments as to adequacy of method of securing filler hole plug to prevent loss.

e. Ease of closing air inlet when wearing gloves.

6.3.5.4.4 Comfort of Inflatable Pad -

Record the following:

a. Comfort of properly inflated pad.

- 1) Too hard?
- 2) Too soft?
- 3) Tendency of sleeper to roll off.

6.3.5.4.5 Quilted Pads -

Record comments regarding adequacy of quilting to prevent shifting and bunching of filling material.

6.3.5.5 Tropic and Temperature Zone Sleeping Bags.

Record:

- a. Thermal insulating properties.
- b. Weight and bulk comparative data.

6.3.5.6 Compatibility of Case and Bag.

Record:

- a. Evidence of any misalignment of lacing eyelets or snaps.
- b. Comments on adequacy of furnished laces. Ability to tie when wearing gloves.
- c. Does case tend to fold and snag slide fastener closure of the bag?
- d. Does case restrict the size of the bag by being too small?
- e. Is the case too large for the bag? Could it be made smaller?

6.3.6 Durability

Record data required by applicable procedures of MTP 10-2-502 and the following:

6.3.6.1 Materials Characteristics

Record a statement as to the suitability of the following materials for their intended use and the probability of their withstanding continued usage in the field without undue degradation, and the following:

- a. Metal Components (if any).
  - 1) Hardness. Data collected as described in ASTM Standards Manual; E140 (see para 6.2.2.1 a.1).
  - 2) Corrosion. Data collected as described in Federal Test Method Standard No. 151; Method 811 Salt Spray Test (see para 6.2.2.1 b.1).
- b. Textile Materials.
  - 1) Data collected as described in ASTM Standards Manual for:
    - a) Abrasion: D1175 (see para 6.2.2.1 b.1 a).



MTP 10-2-160  
14 July 1971

- b) Tear Strength: D1424; D2261 (see para 6.2.2.1 b.1 b).
  - c) Break Strength: D1682 (see para 6.2.2.1 b.1 c).
  - d) Elongation: D1682 (see para 6.2.2.1 b.1 d).
  - e) Air Permeability: D737 (see para 6.2.2.1 b.1 e).
  - f) Stiffness: D1388 (see para 6.2.2.1 b.1 f).
  - g) Fiber Identification: D276 (see para 6.2.2.1 b.1 g).
  - h) Fiber count: D276 (see para 6.2.2.1 b.1 h).
  - i) Flammability: D1230 (see para 6.2.2.1 b.1 i).
  - j) Color fastness to weather of cloth-accelerated: E42 (see para 6.2.2.1 b.1 j).
  - k) Water absorption tests: D583 (see para 6.2.2.1b.1 k).
- 2) Data collected as described in AATCC Manual for:
- a) Color fastness to light-accelerated Method: Procedure 16F-1964T (see para 6.2.2.1 b.2 a).
  - b) Crocking: Procedure 8-1961 (see para 6.2.2.1 b.1 b).
  - c) Static charge tests: Procedures 76-1964 (see para 6.2.2.1 b.1 c).
- 3) Data collected as described in Federal Standard CCC-T-191 for:
- a) Resistance to accelerated aging: Method 5512.2 (see para 6.2.2.1 b.3 a).
  - b) Adhesion of coating: Method 5970 (see para 6.2.2.1 b.3 b).
  - c) Blocking: Method 5651 (see para 6.2.2.1 b.3 c).
  - d) Sealed seam sealant-resistance to low temperature flexing: Method 5874 (see para 6.2.2.1 b.3 d).
  - e) Color fastness and legibility of labels: Method 5651-1 (see para 6.2.2.1 b.3 d).
  - f) Weatherometer tests for accelerated weathering: Methods 5804.1, 5512.2 (see para 6.2.2.1 b.3 e).
  - g) Puncture: Method 5120 (see para 6.2.2.1 b.3 f).
- 4) Data collected as described in Federal Standard KK-L-311: Method 5011 covering Mildew resistance tests (see para 6.2.2.1 b.4).

#### 6.3.6.2 Launderability

Record the following: (see para 6.2.2.2).

- a. Data obtained from repeat of subtest in para 6.2.1.1 (see para 6.3.5.1) after 25 wash cycles.
- b. Data obtained from repeat of subtest in para 6.2.1.1 after a total of 50 wash cycles.

6.3.7 Environmental Tests

See data recorded in the following paragraphs:

- a. Paragraph 6.3.3 Physical Characteristics, sub-paragraph g. Salt Fog Test and evidence of corrosion.
- b. Paragraph 6.3.5.2 Moisture Uptake.
- c. Paragraph 6.3.6.1 Materials Characteristics (as applicable).

6.3.8 Transportability

Record the data required by applicable procedures of MTP 10-2-503 and the following:

- a. Results of visual inspection before testing:
  - 1) Defects, if any.
  - 2) Evenness of filler material distribution.
- b. Accurate weight (to hundredth of a pound).
  - 1) Control item.
  - 2) Test item.
- c. Volume when rolled (folded) for man-transportability.
  - 1) Control item.
  - 2) Test item.
- d. Data collected as described in MIL-STD-810B, Method 514, Procedure X, Time Schedule IV for Vibration Test (see para 6.2.3 c.1).
- e. Condition of filler material distribution after test:
  - 1) Evenly distributed.
  - 2) Uneven; bunched

6.3.9 Maintenance Evaluation

Record the data required by applicable procedures of AMCP 706-134, MTP 10-2-507 and Appendixes A and B to USATECOM Regulation 750-15.

6.3.10 Reliability

Record data required by applicable procedures of MTP 10-2-512.

MTP 10-2-160  
14 July 1971

6.3.11      Safety

Record the following:

- a. Any dangerous or unsafe condition or any condition that might present a safety hazard including the cause of the hazard.
- b. Safety features incorporated into test item design with comments as to adequacy of quick release feature of closure.
- c. Adequacy of warning instructions and markings.
- d. Suggestions to improve the existing safety precautions.

6.3.12      Human Factors Evaluation

Record the following:

- a. Data required by applicable procedures of MTP 10-2-505.
- b. Checklists (complete according to HEDGE criteria).
- c. Retain completed technical performance questionnaires.
- d. Noted inadequacies of test item design affecting ease of test item use with comments on the following:
  - 1) Ease of operation of slide fastener.
  - 2) Adequacy of auxiliary closure.
  - 3) Adequacy of lacings (if present).
  - 4) Adequacy of neck and head area closure.
  - 5) Ease of entering sleeping bag when wearing woolen socks and underwear.
  - 6) Ease of operating valve or other closure of inflatable pad or mattress.
- e. Recommendations to improve man-item effectiveness.

6.3.13      Value Analysis

Record the following:

- a. Nonfunctional, costly, or "nice-to-have" features of test item.
- b. Test personnel comments and opinions regarding features which could be eliminated in accordance with criteria of USATECOM Regulation 700-1.

6.3.14 Quality Assurance

Record:

- a. Data required by MTP 10-2-511.
- b. Comments as to any design shortcomings in the area of required quality.

6.4 DATA REDUCTION AND PRESENTATION

Data obtained during the conduct of this test will be summarized making use of photographs and charts as appropriate. All photographs and charts will be properly identified and labeled. Test data will be obtained for each item tested, and summarized and evaluated as required.

Data obtained for each performance characteristic will be compared with established technical performance characteristics as specified in MN or other developmental criteria. Test data obtained for different items undergoing the same test, or for the same item undergoing a repeated test, will be compared, and where differences occur, the differences shall be noted and summarized giving the degree of difference and the cause of the difference. The heat loss through a sleeping bag shall be calculated from the data collected as specified in paragraph 6.2.1.1 above and in accordance with the information and formulas in Appendix C of this document.

The presentation shall conclude with a summarization of the suitability of the test item for service testing.

# APPENDIX A

## CRITERIA FOR EVALUATION OF INSULATION PROPERTIES OF SLEEPING BAGS

About 21 subjects, used in more than 200 sleeping bag experiments in the cold room of the Harvard Fatigue Laboratory furnished subjective judgements of the adequacy of insulation provided by different bags at various temperatures. From comparison of the subjective data with objective data obtained during the same experiments it has been possible to set up objective criteria for determining the adequacy of any sleeping bag. The most reliable criteria are given in the table below. Usually a bag fails according to several of these criteria if it fails at all.

Criterion	Adequate Bag	Doubtful Bag	Inadequate Bag
Heat loss through bag in Calories per square meter of body surface per hour.	30-40	40-45	Above 45
Lowest temperature on skin of great toe.	Above 70°F.	65-70°F.	Below 65°F.
Lowest temperature on skin of lower thigh.	Above 85°F.	80-85°F.	Below 80°F.
Lowest average temperature of skin of trunk.	Above 91°F.	89-91°F.	Below 89°F.

With techniques developed by the Harvard Fatigue Laboratories calculated values for heat loss through a sleeping bag are usually duplicated within  $\pm 2$  calories per square meter per hour if performed again on the same man; they generally agree within  $\pm 4$  calories on a different man.

Determinations made at different temperatures on the same bag generally give values for heat loss through the bag which increase by about 3.5 calories per square meter per hour for each 10°F. fall in environmental temperature between 37 and 60 calories. From a value obtained at one temperature, therefore, it is possible to predict what the value will be at others. An average value is 3.5 Calories per 10°F. Actually, from theoretical considerations and from actual experiments, it is known that this value is somewhat higher for the bags affording less insulation and vice versa.

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From Appendix 2 of Report No 10, Harvard Fatigue Laboratory to Office of the Quartermaster General, Subject: Further Observations on the Insulation Provided by Experimental Sleeping Bags. -- H.S. Belding, R.C. Darling, E.S. Turrell and Dr. Sid Robinson.

APPENDIX B - QUESTIONNAIRES

Questionnaire I - "Usual" Sleeping Habits

1. Approximately at what time do you normally go to bed? At \_\_\_\_\_ hours
2. How soon do you normally fall asleep?  
☐ almost immediately      ☐ within 1/2 hour      ☐ later
3. How many hours do you usually sleep? \_\_\_\_\_ hours
4. Do you normally sleep in a room that is . . .  
☐ very warm      ☐ moderately warm      ☐ cool      ☐ air conditioned
5. What is your normal sleep covering?  
☐ pajama pants/shorts      ☐ pajama jacket      ☐ sheet  
☐ one blanket      ☐ two blankets      ☐ more, specify\_\_\_\_
6. Do you prefer a bed that is . . .  
☐ very soft      ☐ medium      ☐ very hard
7. How is your sleep?  
☐ continuous, deep      ☐ continuous, light      ☐ occasional awakening, good sleep  
☐ occasional awakening poor sleep      ☐ frequent turning or tossing
8. Are you easily awakened?  
☐ by light      ☐ by sound      ☐ by heat      ☐ by cold      ☐ no
9. Do you occasionally lie awake any part of the night?  
☐ yes, during early part      ☐ yes, during late part      ☐ no
10. Do you occasionally take a sleeping tablet?  
☐ yes, at bedtime      ☐ yes, to fall asleep again      ☐ no

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Dr. Ralph Goldman, Army Research Institute of Environmental Medicine,  
assisted in the preparation of all questionnaires.

MTP 10-2-160

14 July 1971

11. Do you often have something to drink before going to bed?

If so, what kind of beverage?

- ☐ water/milk   ☐ cola   ☐ other soft drink   ☐ coffee or tea  
☐ beer   ☐ alcoholic beverage   ☐ no

12. Do you get up to urinate during the night?

- ☐ only ocassionally   ☐ often, in the night  
☐ often, in the early ~~morning~~   ☐ never

13. Do you sleep equally well in a bed different from your own?

- ☐ yes, always   ☐ only when tired   ☐ no

Questionnaire II - Sleep

1. Were you comfortably warm during the night?

- ☐ yes, all the time                      ☐ only during first part  
☐ only during last part                      ☐ no

2. Did you fall asleep within approximately 15 minutes? ☐ yes ☐ no

3. If no, what kept you from falling asleep?

- physical disturbances,                      ☐ disturbances by thoughts  
specify \_\_\_\_\_ ☐ awareness of cold  
\_\_\_\_\_

4. Were you ever awakened by any disturbance?

- ☐ yes                      ☐ no                      ☐ already awake

5. If already awake, what was the cause?

- ☐ disturbance by noise, light or movement                      ☐ feeling of coolness

6. Did you fall asleep (again) shortly after the disturbance?

- ☐ yes, immediately                      ☐ yes, after \_\_\_\_\_ minutes  
☐ no

7. If no, what kept you from falling asleep?

- ☐ physical disturbances                      ☐ disturbance by thoughts  
specify \_\_\_\_\_ ☐ need to urinate  
☐ awareness of cold                      ☐ being too cold (tense or shivering)  
☐ other cause, specify \_\_\_\_\_

8. If you slept (or fell asleep after being awakened) how was your period of sleep?

- ☐ continuous - deep                      ☐ continuous - light  
☐ intermittent - good                      ☐ intermittent - poor                      ☐ increasingly difficult



Questionnaire III - Cold

1. What caused you to wake up in the cold? (x in box for first awakening, circle box for subsequent awakenings.)

<input type="checkbox"/> general feeling of cold	<input type="checkbox"/> cold feet	<input type="checkbox"/> cold skin on _____
<input type="checkbox"/> pain in _____	<input type="checkbox"/> tensed muscles	<input type="checkbox"/> light shivering
<input type="checkbox"/> violent shivering	<input type="checkbox"/> need to urinate	<input type="checkbox"/> habit
<input type="checkbox"/> other reasons (e.g. noise, equipment, etc.), specify _____		

2. Grade your sensation of cold during the stated hours of the night (approximate) by marking the appropriate box.

11-1	1-3	3-5	5-7	
				None (or asleep)
				Mild
				Moderate
				Severe
				Unbearable

3. Grade the occurrence and type of shivering experienced during the stated hours (approximate) by marking the appropriate box with one of the following numbers:

0 = relaxed  
1 = tense muscles  
2 = light shivering  
3 = violent shivering

11-1	1-3	3-5	5-7	
				None
				One short period
				Continuous
				Intermittent, long periods
				Intermittent, short bursts

4. What uncomfortable sensations did you experience from the cold, and where?

<input type="checkbox"/> None	<input type="checkbox"/> number _____	<input type="checkbox"/> prickly _____
<input type="checkbox"/> stinging _____	<input type="checkbox"/> painful _____	

5. How many times did you urinate and during what part of the night? Mark the number in the appropriate box; if none, mark 0.

11-1	1-3	3-5	5-7

MTP 10-2-160  
14 July 1971

6. Were you restless or moving around in bed in any part of the night?

11-1	1-3	3-5	5-7
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

restless  
turned over

☐ no

MTP 10-2-160  
14 July 1971

#### APPENDIX C

##### HEAT LOST THROUGH A SLEEPING BAG BY A HUMAN TEST SUBJECT

In order to assess the heat lost through a sleeping bag, an instrumented test subject sleeps in the test item for 3 hours in the appropriate environmental temperature and wind conditions. Measurements are made during the second and third hours which permit calculation of body loss or gain in stored heat ( $\Delta^S$ ), heat production (M), heat dissipation by evaporation of vapor from the lungs and skin (E), and heat lost in warming the inspired air from environmental temperature to 33°C. (WA); the last two are avenues of heat loss other than through the bag.

$\Delta^S$  is calculated from the weighted average of skin temperature at 7 points ( $T_S$ ), and rectal temperature ( $T_R$ ) obtained by thermometer at 60, 120, and 180 minutes. Then, according to Burton's @ formula:

$$0.30 T_S + 0.70 T_R = T_A; \text{ the mean temperature of the body mass.}$$

Then:  $\Delta^S$  per hour =  $\Delta T_A \div 1.8 ** \times 0.83 *** \times \text{body weight in Kg.}$

Oxygen consumption in liters is calculated from a continuous record for 60 to 120 to 180 minutes, then converted to heat production in Calories per hour (M) by multiplying by 4.9 (appropriate Calorie value of one liter of oxygen under these test conditions).

Then the hourly heat loss through the bag (HB) in Calories per hour =  $M - E - WA + S$ ; E is determined from Weight loss measured to the nearest gram on a Sauter balance.

$$HB \div \text{Surface Area} = \text{Heat loss through the bag in Calories per square meter of body surface per hour. (Cals./m}^2\text{/hr.)}$$

Using the above techniques it was found that the calculated values for heat loss through a bag were usually duplicated within  $\pm 2$  Calories per square meter per hour if performed again on the same test subject; they generally agreed within  $\pm 4$  Calories on different test subject.